Status Of Inboard/Sterndrive Catalyst Testing

October 28, 2004

California Environmental Protection Agency
Air Resources Board

Outline

- Regulatory Background
- On-Water Demonstration Project
- Other Related Issues
- Conclusions

Outboard Engines

Personal Watercraft

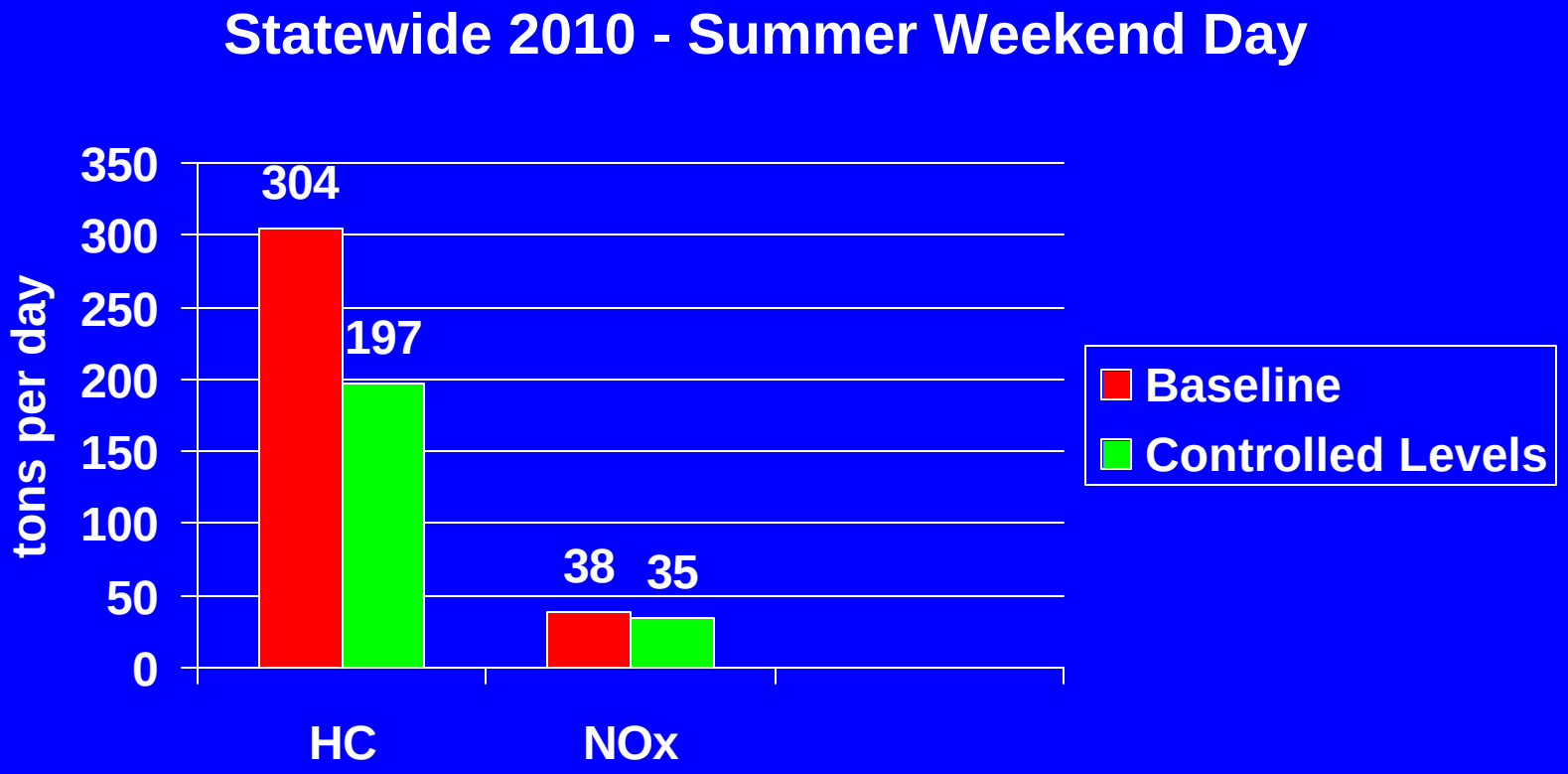
Outboard/PWC Rulemakings

- 1996: Federal Outboard/PWC
  - Implemented in 1998
  - Standards gradually more stringent
  - Most stringent in 2006

Outboard/PWC Rulemakings

- 1998: California Outboard/PWC
  - Major contributor to weekend ozone
- 2001: Equal to 2006 Federal Standards
- 2004: 20% cleaner than CA 2001
- 2008: 65% cleaner than CA 2001
- Cost Effective

Benefits of Outboard/PWC Regulation



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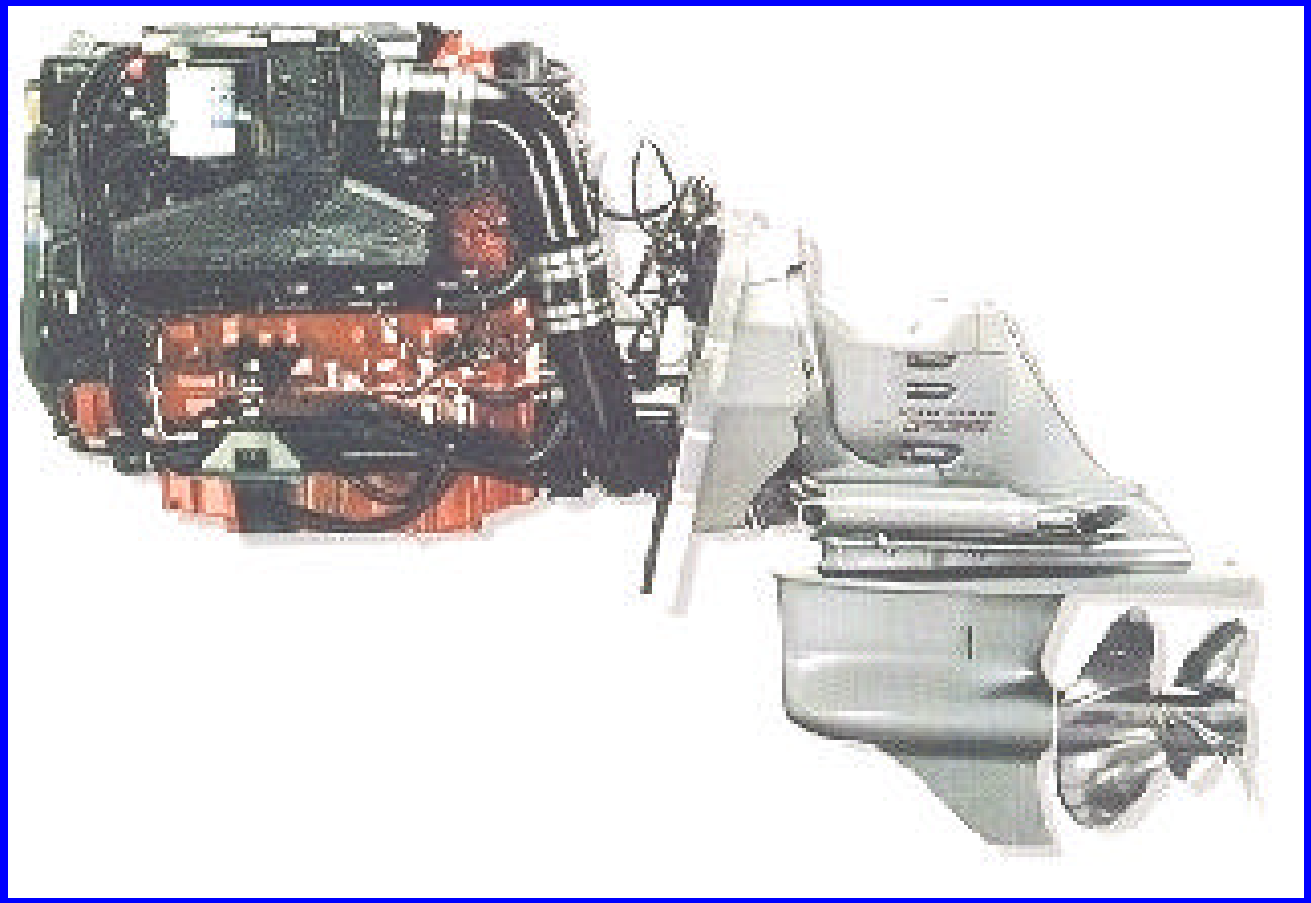
Inboard Boat

Inboard Engine

Sterndrive Boat

Sterndrive Engine



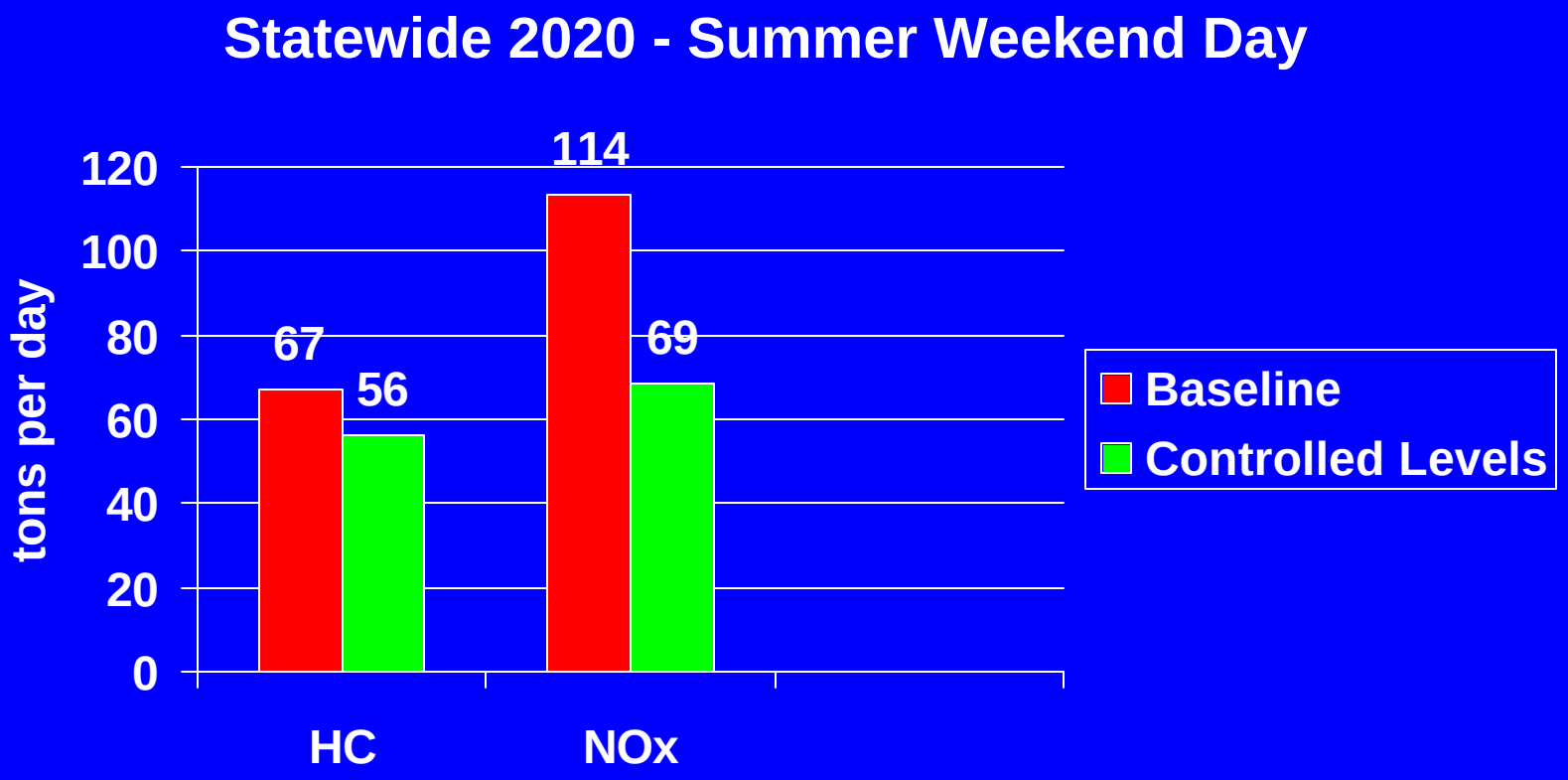
Inboard/Sterndrive Rulemaking

- 2001: California Inboard/Sterndrive
  - Addresses remainder of gasoline recreational boat emissions
  - Catalyst-based standards adopted
  - Resolution 01-23: On-water Demonstration
    - Safety
    - Durability

Inboard/Sterndrive Emission Standards

- 2003: 16 g/kW-hr HC+NO_x
- 2007: 5 g/kW-hr HC+NO_x
  - 2007 45%
  - 2008 75%
  - 2009 100%
- On-Board Diagnostics (OBD)
  - 2007 more basic
  - 2009 more advanced
- Cost Effective

Benefits of Inboard Regulation



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On-Water/Catalyst Project

Aim of Project

- Demonstrate catalysts are safe
- Demonstrate catalysts are durable

On-Water/Catalyst Project

Project Participants

- ARB: Project Manager
- NMMA: Boats and Engines
- MECA: Emission Control Devices
- U.S. Coast Guard: Boat Drivers
- SwRI: Project Contractor

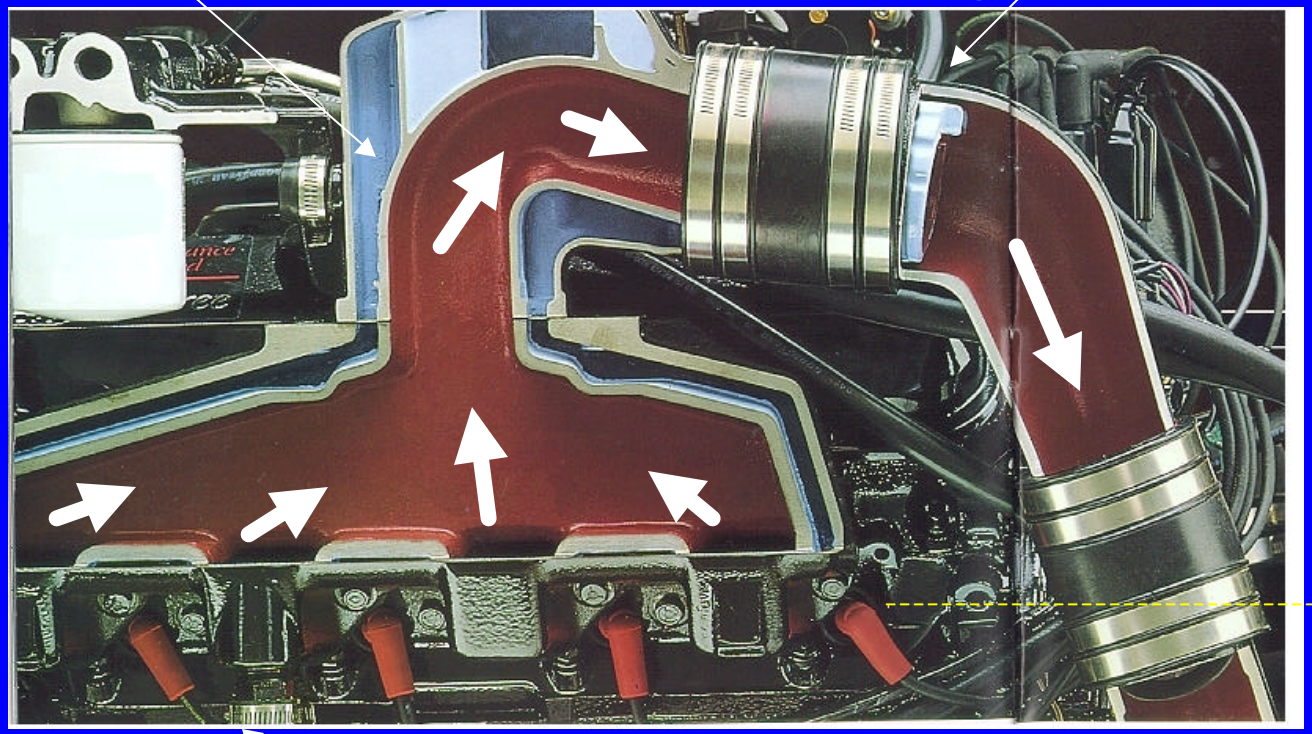
On-Water/Catalyst Project

- Boats:
  - 4 Inboard/Sterndrive Boats
- Control System:
  - Catalyst Exhaust Systems
  - Closed-Loop Fuel Control
- Test Plan:
  - 0-hour, On-Water, 480-hour Sampling

Exhaust Manifold Cutaway

Exhaust Manifold Water Jacket

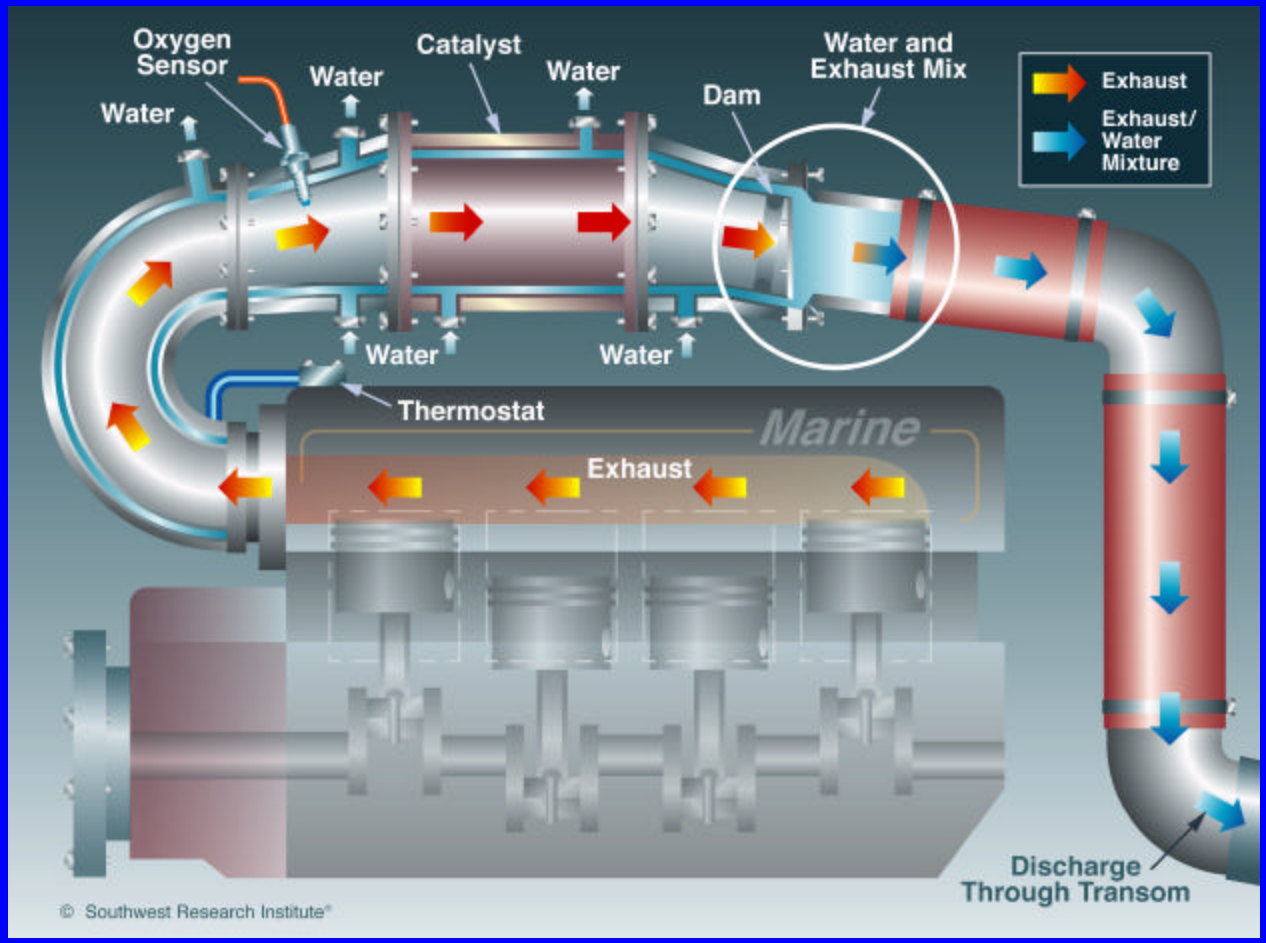
Point of Water and Exhaust Mixing



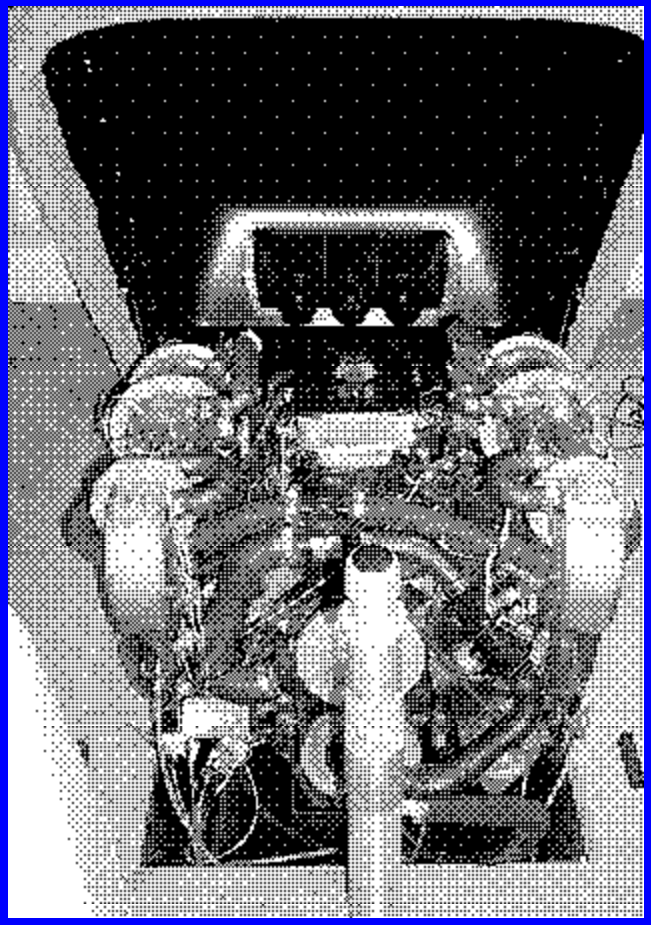
Water Level

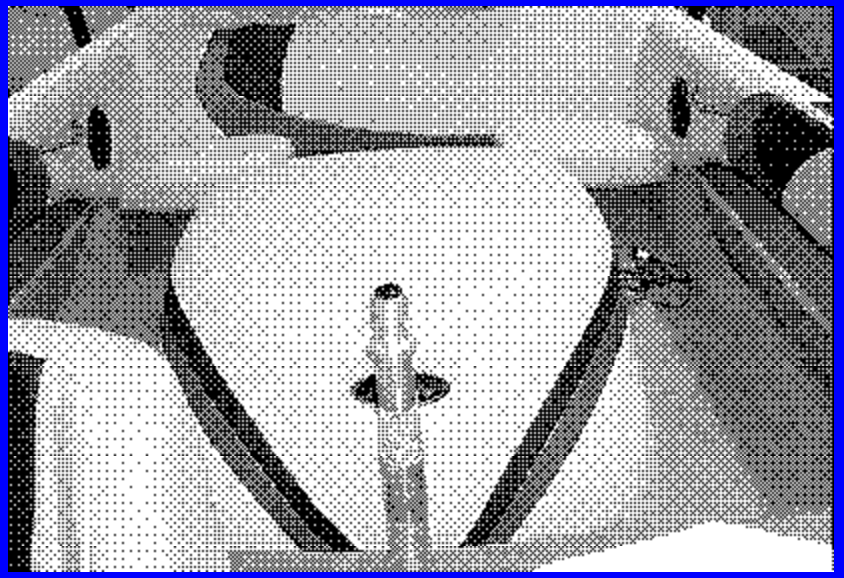
Jacket Water Inlet

Catalyzed Exhaust System

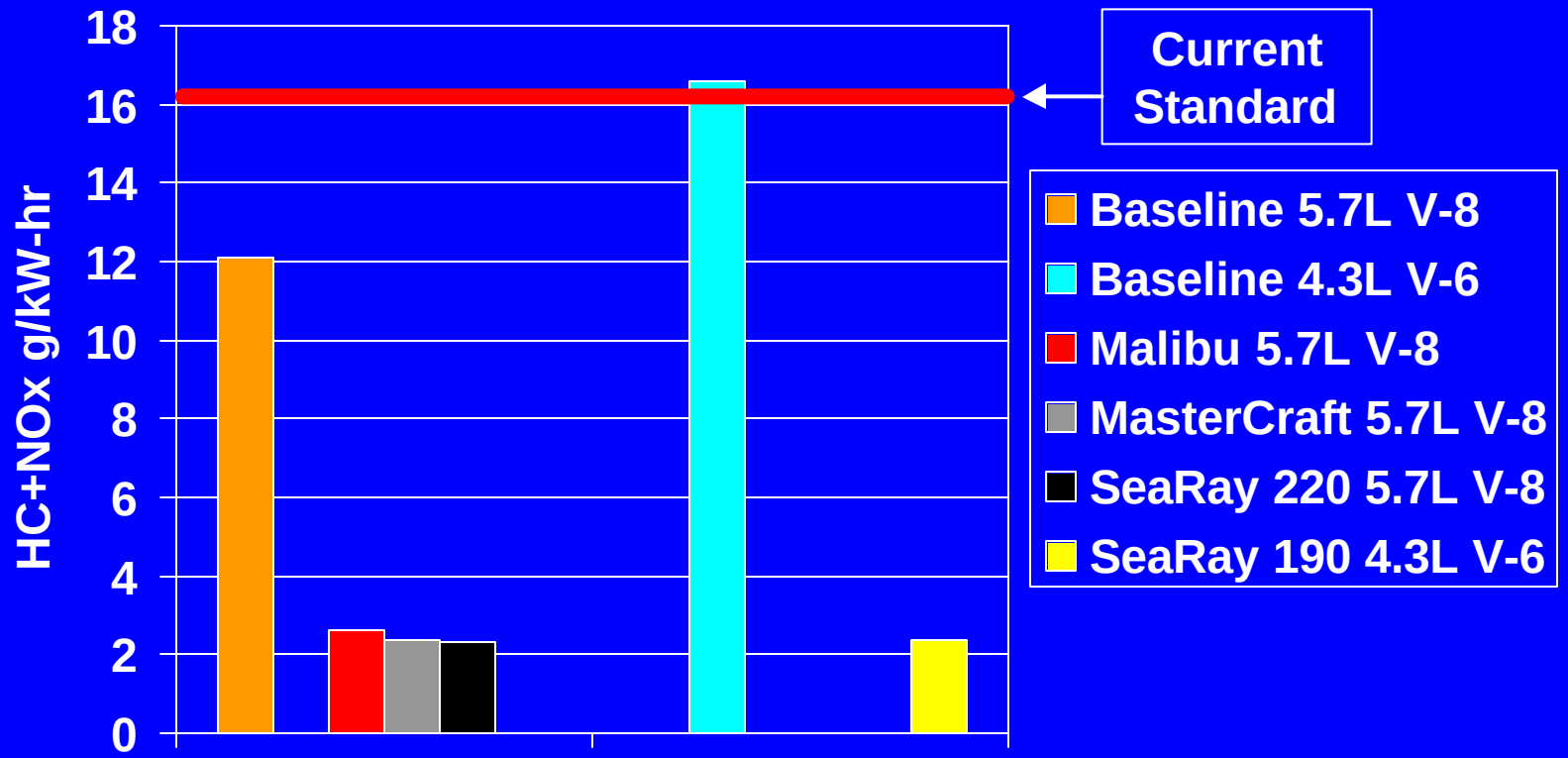


Catalyzed Inboard Engine

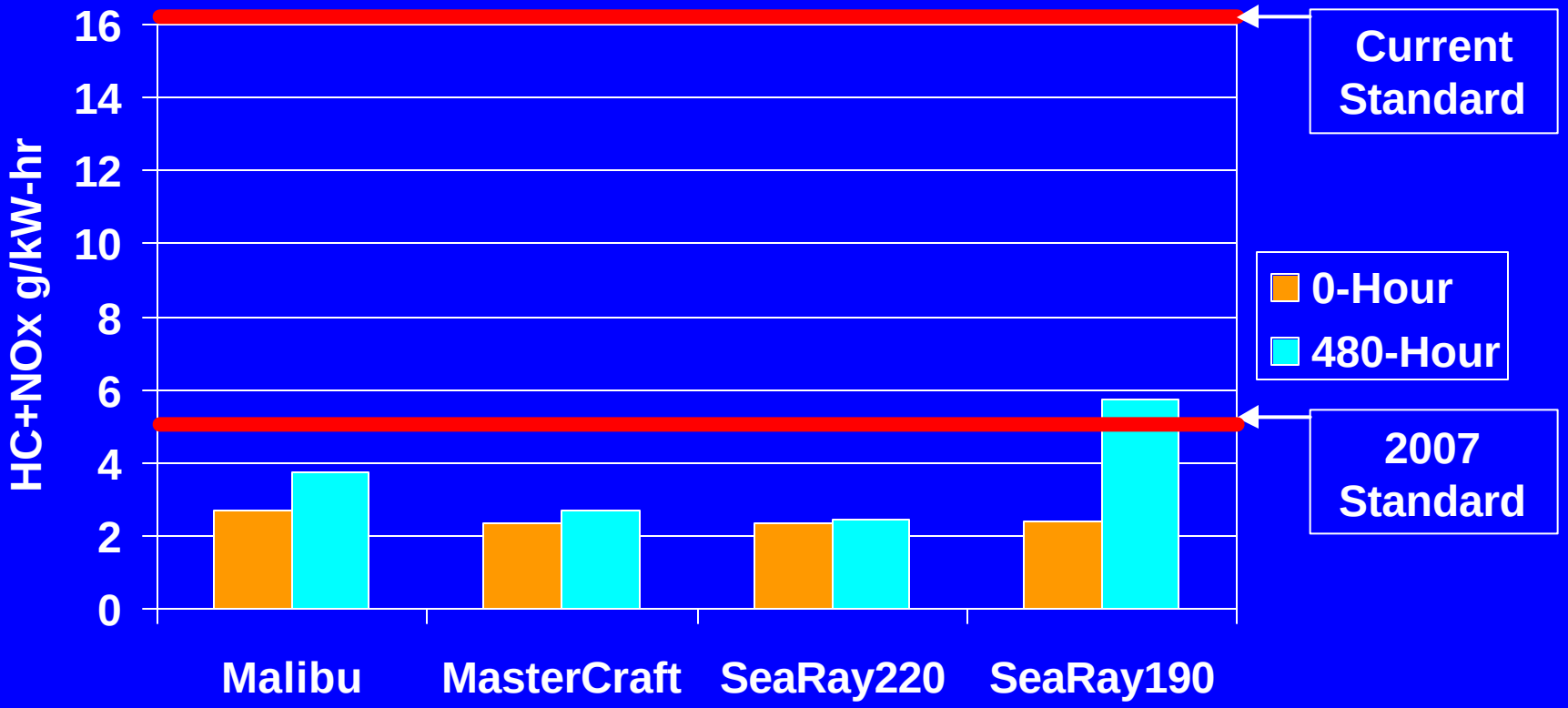




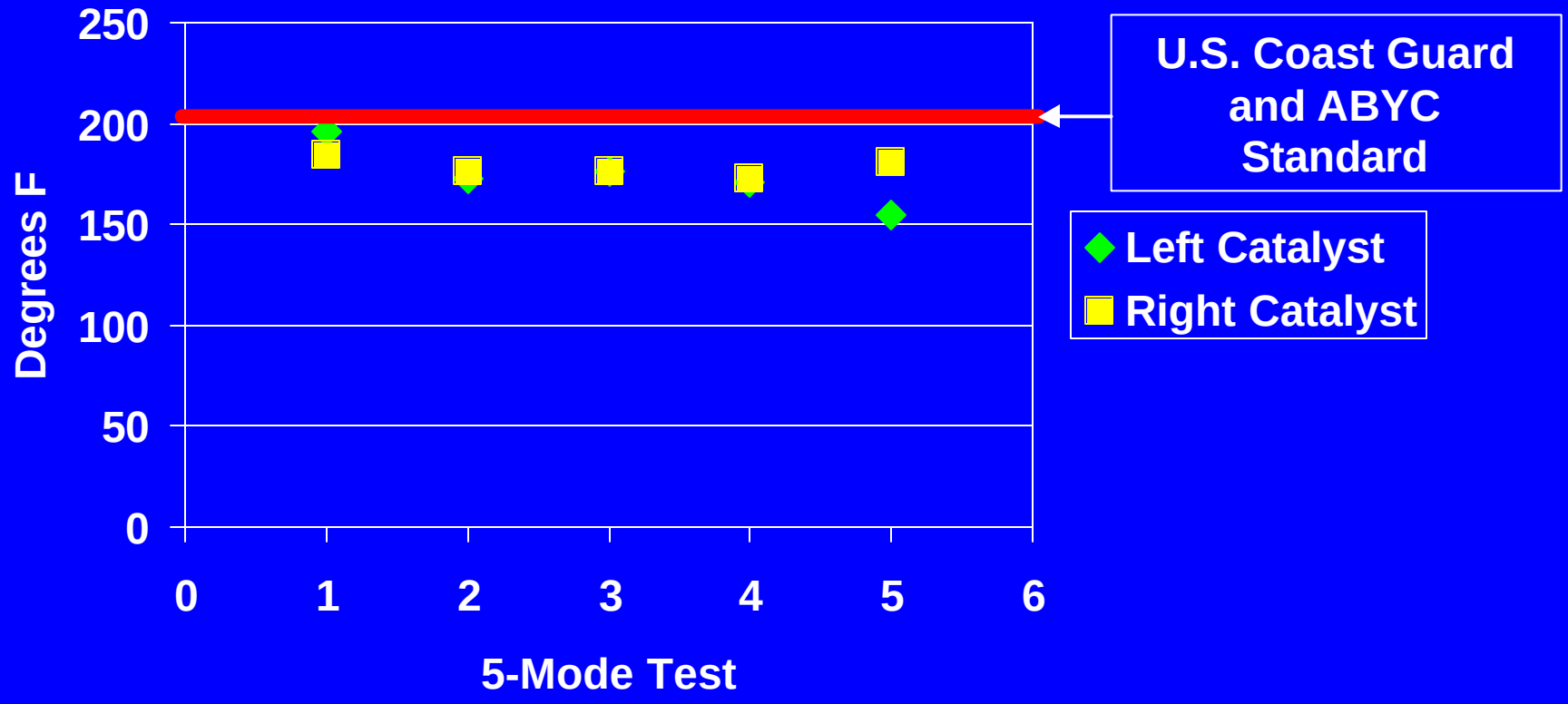
$HC+NO_x$ Emissions (0-hour): Baseline vs. Catalyst



$HC+NO_x$ Emissions: 0-Hour vs. 480-Hour

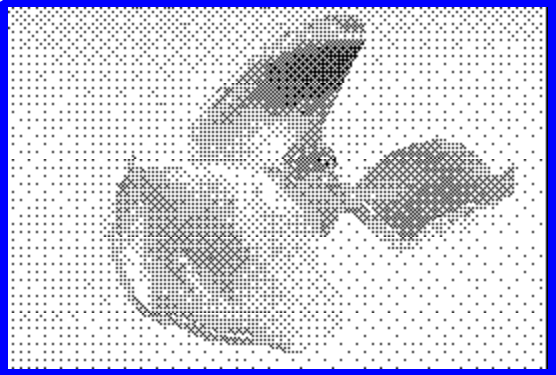


Exhaust “Skin” Temperature



Project Issues

- Some mechanical problems
  - Cracked manifolds
  - Hot-start issue
  - Propeller replacement
  - No impact on catalyst durability or safety



- Mechanical problems not related to catalysts or emission control systems

Other Issues

- U.S. EPA Activity
  - Proposing Evaporative Standards
  - Proposing Carbon Monoxide (CO) Standards?
  - Harmonizing with California?
  - Early 2005 Proposal

Other Issues (cont'd.)

- CO Emissions and Exposure
  - 1,200 ppm endangers health
  - NIOSH "REL" standard: 35 ppm (200 ppm ceiling)
  - CO concentrations from non-catalyst engines
    - Lake Norman, NC: 500-1,000 ppm (peak above 1,000)
  - CO concentrations from catalyst-equipped engines
    - Canyon Lake, TX: below 35 ppm (peak below 200)
  - U.S. Coast Guard "CO workshops"
  - Legislation: AB 2222

Other Issues (cont'd.)

Industry's Requests

- Change implementation date
  - Regs contain a 2007-2009 phase-in
  - Industry prefers a 100% implementation in 2008
  - Air Quality impact is small

Other Issues (cont'd.)

Industry's Requests

- Emission "averaging" for 500+ hp engines
- On-Board Diagnostics for Catalysts
  - Regs contain a 2007-2009 phase-in
  - Industry prefers a 2008-2012 phase-in
- Salt water testing

Conclusions

- Demonstration showed:
  - Catalysts are safe and durable
  - Catalyst-based emission standards are achievable
- Staff will continue discussions with industry on possible regulatory changes
- Salt water testing
- Staff will update the Board, if necessary